

# The systematic position of *Acanthalburnus microlepis* (De Filippi, 1863) and contributions to the genus *Acanthobrama* (Cyprinidae: Leuciscinae) in Turkey

Fahrettin KÜÇÜK<sup>1\*</sup>, Yusuf BEKTAŞ<sup>2</sup>, Salim Serkan GÜÇLÜ<sup>1</sup>, Cüneyt KAYA<sup>2</sup>

<sup>1</sup>Süleyman Demirel University, Eğirdir Fisheries Faculty, Eastern Campus, Isparta-Turkey

<sup>2</sup>Recep Tayyip Erdoğan University, Fisheries Faculty, Rize-Turkey

Email: fahrettinkucuk@sdu.edu.tr

**Abstract:** In this study, the systematic position of *Acanthalburnus microlepis* from Kura and Aras basins is clarified and some notes on the taxonomy of the *Acanthobrama* species distributed in Turkey are given. Based on the morphological and osteological analyses, a high similarity between *A. microlepis* and *Acanthobrama* members is found. Some taxonomic information yielded from the examination of recent collections from Dicle (Tigris), Fırat (Euphrates), Asi (Orontes), Ceyhan, Seyhan rivers and Berdan Stream near Tarsus is also included. Accordingly, *Acanthobrama marmid* is distributed only in Dicle-Fırat system (presumably also in Sinnap Stream from Kuveik Drainage) and the populations from Asi, Seyhan and Berdan Stream (Tarsus) regarded as a separate subspecies as *A. marmid orontis* Berg, 1949 should be considered full species according to phylogenetic species concept and Ceyhan population represents a new species.

**Keywords:** *Acanthalburnus*, *Acanthobrama*, Inland water fishes of Turkey, Systematics.

## Introduction

Taxonomy of the family Cyprinidae has always been under debate among taxonomists. Based on morphological characters, the family has been split into 2 to 12 subfamilies according to various authors (Chen et al. 1984; Bogutskaya 1997; Kottelat & Freyhof 2007). Most diverse of the family, the subfamily Leuciscinae from Europe and North America was even erected to family level (Mayden & Chen 2010). Subfamily Leuciscinae is known to be represented by 54 species belonging to 17 genera in Turkey (Bogutskaya 1997). Perea et al. (2010) grouped 176 Circum-Mediterranean Leuciscinae species into 14 main clades based on molecular markers.

The Leuciscinae genus *Acanthalburnus* Berg 1916 was characterised by Berg (1949) as a monotypic genus close to *Alburnoides*, differing from the latter by the spine-like thickened last simple

dorsal-fin ray. The following morphological features are also characteristic for the genus: mouth oblique or subterminal; caudal fin long and deeply notched; lateral line complete, with 68-82 pored scales, 13-15 scales between lateral line and dorsal-fin origin, 6-8 scales between lateral line and pelvic-fin origin; dorsal fin with 8½ branched rays; anal fin with 13-17½ branched rays; gill rakers stout and short, 10 gill rakers on the first branchial arch; pharyngeal teeth 2.5-5.2 or 2.5-4.2, not serrated, the largest may be markedly serrated; a dark and wide stripe along lateral midline from eye to caudal-fin base; dorsal and caudal fins black at tips. Distribution of the genus is restricted to the Kura River drainage including its tributary Aras, excluding the lower reaches of the Kura, and Lake Orumiyeh (Urmia) basin (Coad 2014). It is mentioned as the only endemic genus of the Kura drainage (Bogutskaya 1997).

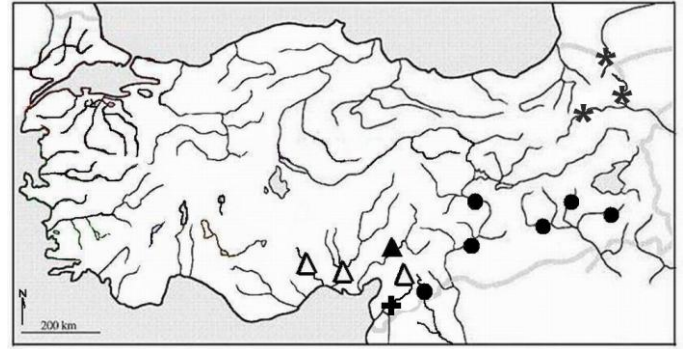
According to Esmaeili et al. (2010) and Coad

(2014), *Acanthalburnus* consists of two rather morphologically similar, but geographically isolated species, *A. microlepis* (De Filippi, 1863) and *A. urmianus* (Günther, 1899), in Iran. Durand et al. (2002) placed the genus among *Abramis* clade according to cytochrome b data, while Perea et al. (2010) proposed synonymy with *Acanthobrama* using mitochondrial and nuclear DNA data. Based on the latter, Eschmeyer (2014) included *Acanthalburnus microlepis* in *Acanthobrama*. However, until now, no morphological study on validating this genus change has been presented.

The genus *Acanthobrama* characterised by a thickened and smooth last unbranched dorsal fin ray and a naked ventral keel on the belly between the anus and the pelvic fins (Heckel, 1843). *Acanthalburnus microlepis* share the same diagnostic characters with the genus *Acanthobrama*. Additionally, no recent study was conducted on the taxonomy of the genus *Acanthobrama* in Turkey. Heckel (1843) described *A. centisquama* (Damascus), *A. marmid* (Kuveik), *A. cupida* (Kuveik) and *A. arrhada* (Dicle River, Tigris-Euphrates drainage) and noted that *A. centisquama* could easily be identified by small scales (100 in the lateral line). The type locality of *A. centisquama* as at Damascus given by Heckel (1843), is a labelling error according to Coad (1984) as the species was confined to Asi River and Amik Lake only (Fig. 1). So, the aim of this study is to clarify the taxonomy of these two genera in Turkey, based on their morphology.

### Material and Methods

Fish specimens were caught by pulsed DC electrofishing equipment and killed by over anaesthetization, preserved in 5% formalin. Material is deposited in: IFC-ESUF, Inland Fishes Collection, Eğirdir Fisheries Faculty of Süleyman Demirel University. Counts followed Kottelat and Freyhof (2007). Lateral line scales were counted from the first one to touch the shoulder girdle to the last scale at the



**Fig.1.** Distribution of the genus *Acanthobrama* species in Turkey (\**A. microlepis*, ● *A. marmid*, Δ *A. orontis*, ▲ *Acanthobrama* cf. *marmid*, +*A. centisquama*)

end of the hypural complex. Scales on the caudal fin itself are indicated by “+” (Freyhof & Özuluğ 2009). The last two branched dorsal and anal fin rays articulating on a single pterygiophore were counted as 1½. Vertebral counts were obtained from radiographs and counted as total, predorsal, abdominal and caudal vertebrae following Naseka (1996). Abdominal vertebrae were counted from the first Weberian vertebra to the one just anterior to the first caudal vertebra. The first caudal vertebra is that with its haemal spine fully developed. The count of total and caudal vertebrae includes the last complex vertebra bearing hypurals. Osteological characters were examined in cleared and stained with alizarin Red-S specimens and from radiographs (Bogutskaya 1996).

**Abbreviations:** SL, standard length. D, dorsal fin rays. A, anal fin rays. P, pectoral fin rays. V, pelvic fin rays. C, caudal fin rays. L.L., lateral line. Sq, lateral series. IFC-ESUF, Inland Fishes Collection, Eğirdir Fisheries Faculty of Süleyman Demirel University, Turkey.

### Comparative material (all from Turkey)

*A. marmid*: IFC-ESUF 03-0158, 10, 101.46-122.78 mm SL, Diyarbakır prov., Yenişehir country: Dicle River, C. Kaya, F. Kaya, 17 September 2010.

*A. marmid*: IFC-ESUF 03-0155, 8, 95.25-145.34 mm SL, Muş prov.: Fırat River drainage, Murat Suyu



**Fig.2.** *Acanthobrama microlepis* IFC-ESUF 03.0153, 141.6 mm SL, Akçalar Stream-Aras River.

Stream, C. Kaya, F. Kaya, 13 August 2012.

*Acanthobrama* cf. *marmid*: IFC-ESUF 03-0151, 5, 156.47-184.11 mm SL, Kahramanmaraş prov.: Ceyhan River drainage, Sır Dam Lake, F. Küçük, S. S. Güçlü, 03 November 2012.

*A. marmid*: IFC-ESUF 03-0152, 37, 61.36-120.35 mm SL, Kilis prov.: Kuveik River drainage, Sinnap Stream, F. Küçük, D. Turan, S. S. Güçlü, M. Kamer, C. Kaya, 04 November 2012 and 26 June 2013.

*A. microlepis*: IFC-ESUF 03-0153, 33, 49.76-152.17 mm SL, Kars prov., Arpaçay village: Aras River drainage, Akçalar Stream, F. Küçük, C. Kaya, A. Küçük, 03 June 2013.

*A. orontis*: IFC-ESUF 03-0154, 14, 90.61-149.78 mm SL, Adana prov.: Seyhan River drainage, Seyhan Dam Lake, F. Küçük, D. Turan, S. S. Güçlü, 27 June 2012.

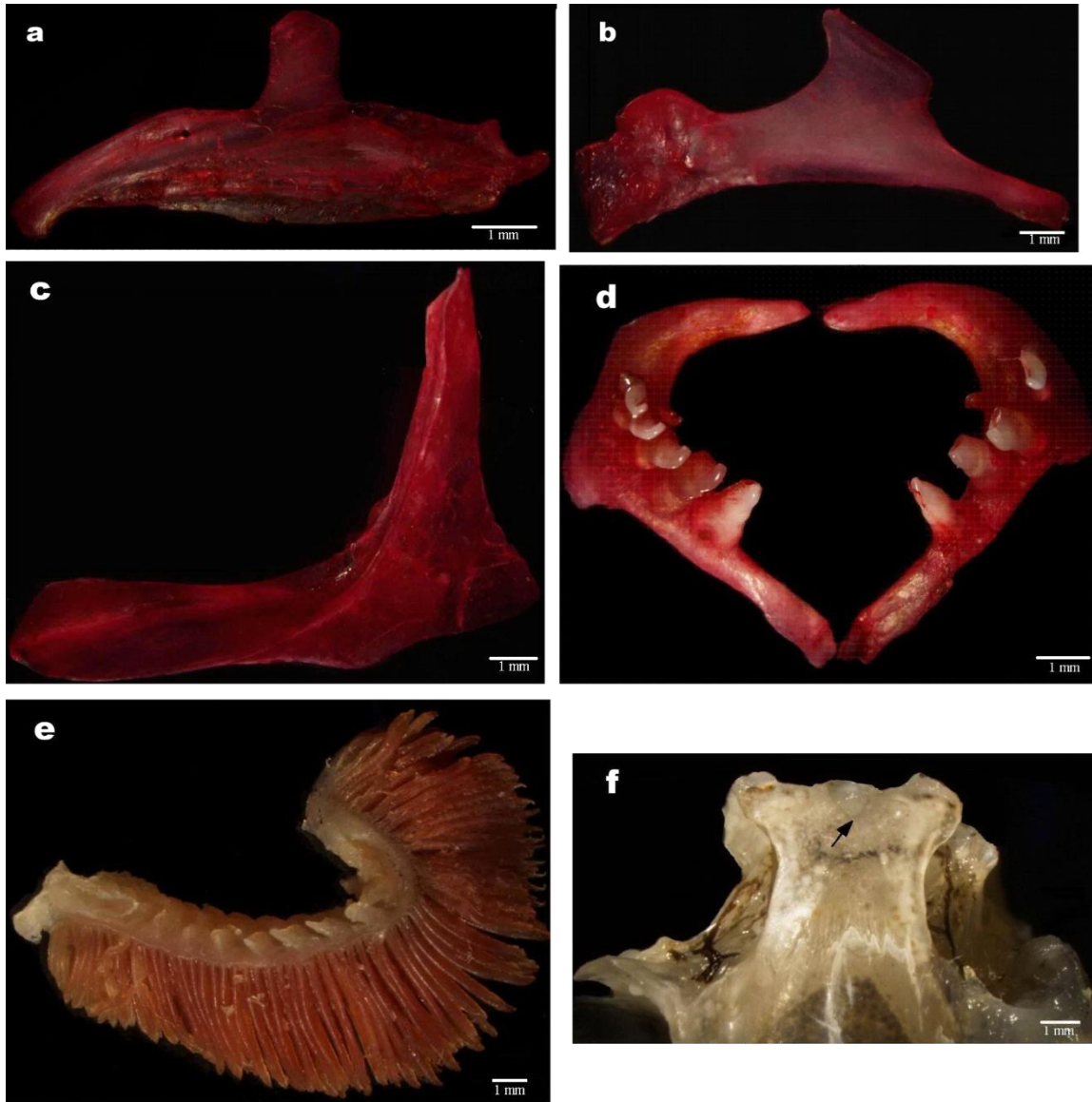
*A. orontis*: IFC-ESUF 03-0156, 12, 116.5-156.76 mm SL, Mersin prov.: Berdan River drainage, F. Küçük, 10 November 2013.

## Results

**Contributions to *Acanthobrama* species distributed in Turkey:** Perea et al. (2010) suggested that *Acanthobrama mirabilis* Ladiges, 1960 (type locality was Büyük Menderes drainage) was synonym of *Vimba mirabilis* (Ladiges 1960). We are supporting Perea et al. (2010), because the genus *Acanthobrama* characterised by a thickened last unbranched dorsal-fin ray (vs. weak in the genus *Vimba*) and a well-developed ventral keel on the belly between the anus

and the pelvic fins (vs. slightly developed) which are lacking in *A. mirabilis*.

**Description and taxonomic features of the genus *Acanthalburnus* Berg, 1916:** The genus is represented only by a single species, *Acanthalburnus microlepis*, according to Berg (1949). The morphological and osteological features are given below. Body distinctly laterally compressed and deep, with prominent keel before dorsal-fin. Mouth small, oblique or subterminal. Predorsal region slanted towards nape, snout rounded. Scales regularly arranged on body (Fig. 2). Fleshy and deep scaleless keel present between anus and pelvic-fin, decreasing in depth in its anterior part. Pelvic-fin long, its origin clearly in front of dorsal-fin origin, pelvic axillary long. Dorsal and anal fins outer margins concave, black banded at tip. Caudal fin very deeply forked and lobes pointed at the tip. Lateral line complete, with 70 (1), 75 (2), 76 (2), 77 (5), 78 (5), 81 (2) and 83 (1)+1-3 perforated scales and 70 (1), 73 (2), 74 (2), 75 (4), 76 (2), 77 (3), 78 (1), 79 (1), 80 (2) and 83 (1)+1-3 scales in lateral series. Dorsal-fin with 3 simple and 8½ branched rays; anal fin with 3 simple and 14 (1), 15 (12), 16 (7)½ branched rays; pectoral fin with 13 (1), 14 (18) and 15 (1) and pelvic fin with 7 (2), 8 (18) branched rays; 10 (3), 11 (17) gill rakers on first branchial arch, thick, truncated, and widely spaced. Fifth ceratobranchial arch thin and sickle-like, bent anteriorly. Pharyngeal teeth 2.5-5.2 or 1.5-5.2, slender and with distinctly bent tips, not serrated.



**Fig.3.** Left dentary (a), maxilla (b), cleithrum (c), pharyngeal teeth (d), gill rakers (e) and supraethmoid (f) bones of *Acanthobrama microlepis*.

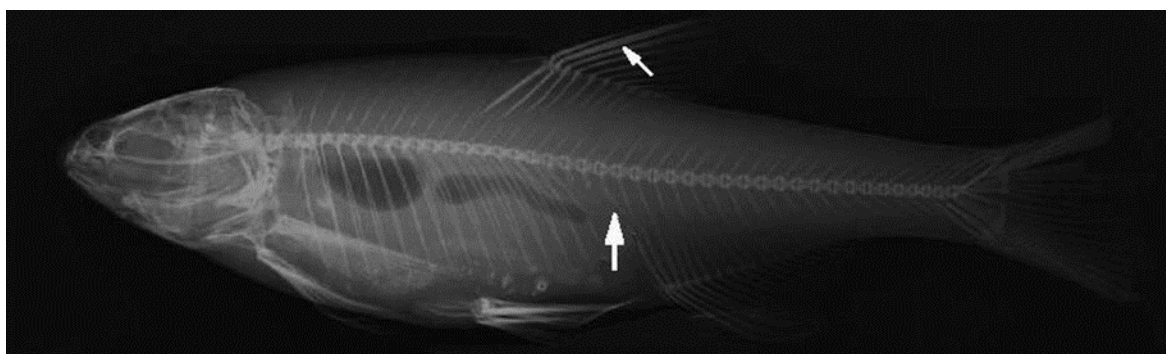
Peritoneum dark smoky, spotted.

Evaluating morphological and osteological features show that *Acanthalburnus* Berg, 1916 is synonym of *Acanthobrama*. Premaxilla thin, the ascendent process long and posterior tip pointed. Maxilla narrow and short, and the ascendent process oblique. Dentary narrow and long, anteriorly concave, the process vertical and positioned in midsection. Cleithrum approximately perpendicular, frontally broadened. Supraethmoid bone short and narrow, anteriorly with a V-shaped slit (notch).

Hyomandibular broad, ceratobranchial arch slender and sickle-shaped (Fig. 3.a-f). Vertebral formulae 44-45: 22-23+22. Relative ratio of abdominal vertebrae 50-51%, predorsal vertebrae ratio 31-32% (Fig. 4).

**Colouration:** When alive body silvery, dorsally body grey or bluish and ventrally with silvery scales. Dorsally, between operculum and upper base of the caudal peduncle, about a 3 scale rows wide and bright grey coloured band present. All fins grey and transparent, outer margins of the dorsal and caudal fins black banded. Pectoral fin base and outer margin





**Fig.4.** Radiograph of *Acanthobrama microlepis* 141.6 mm SL, arrows shows last simple dorsal-fin ray and first caudal vertebra.

with a black band. Pelvic and anal fins orange red in colour.

**Sexual dimorphism:** In males head, nape and dorsal part has large nuptial tubercles, present also in two rows on pectoral and pelvic fins branched rays and on free margins of scales in regular pearly rows. These can be found on the head of females, though not well developed as in males.

**Habitat:** Specimens were collected from Akçalar Stream (Arpaçay, Kars), upper Aras River drainage. Dense populations of fish were observed in sandy and gravel bottom streams at 0.5-1 m depths. *Alburnus filippii* Kessler, 1877, *Barbus cyri* De Filippi, 1865, *Capoeta capoeta* (Guldenstaedt, 1773), *Squalius turcicus* De Filippi, 1865 and *Alburnoides eichwaldii* (De Filippi, 1863) were collected with *Acanthobrama microlepis*.

**Remarks:** In *Acanthalburnus microlepis*, pharyngyal teeth are two rows as 2.5-5.2 or 1.5-5.2, while in *Acanthobrama* species, pharyngyal teeth are generally one row as 5-5 (or rarely 5-1.5). However the genus *Acanthobrama* and *Acanthalburnus* share with same diagnostic characters such as a thickened and smooth last unbranched dorsal-fin ray and a naked ventral keel on the belly between the anus and the pelvic fins (Heckel, 1843). Therefore we consider that *Acanthalburnus* is synonym of *Acanthobrama*.

#### ***Acanthobrama marmid* Heckel, 1843**

The large scales, short pectoral and abdominal fins, and a hump-like dorsal protuberance starting from the nape and pronounced in older individuals were

given as the diagnostic characters in original description of *A. marmid* (Heckel, 1843). Other taxonomic features: snout round and slightly upturned; D: III 8, A: III 17, V: I 8; 65-70 lateral line scales, 9 scale rows between lateral line and dorsal-fin origin, 8-9 scale rows between lateral line and pelvic fin origin. The distribution area was given as the Kuveik River near Aleppo by Heckel (1843) who described two more species from the same region, *A. arrhada* and *A. cupida*, distinguished by eye size (large in *A. arrhada* and moderate sized in *A. cupida*) and strength of last unbranched ray to the dorsal fin (quite strong in *A. arrhada* and weak in *A. cupida*). *Acanthalburnus arrhada* from Dicle River was given a subspecific rank by Karaman (1972) under *A. marmid*. Bogutskaya (1997) reported that *A. marmid* existed in Firat, Dicle, Kuveik and Asi rivers, and Amik Lake, also mentioned probable existence of *A. arrhada* in Berdan Suyu near Tarsus based on the account of Kosswig (1955) (Fig. 5).

Dicle and Firat specimens were congruent in general with the description of Heckel (1843) according to body shape and other morphological characters, with fewer gill rakers and perforating scales in lateral line were noted for Firat specimens in comparison with the original description of *A. marmid*, which gave 65-70 perforating scales, we found 61-67 perforating scales and 14-15 gill rakers on the first branchial arch (Fig. 5). The type locality of *A. marmid* is the rivers near Aleppo and the Kuveik River, however the specimens collected from Sinnap Stream within Kuveik drainage in November



**Fig.5.** *Acanthobrama marmid*, IFC-ESUF 03.0158, 101.5 mm SL, Dicle River (Diyarbakır).



**Fig.6.** *Acanthobrama marmid*, IFC-ESUF 03.0152, 108.6mm SL, Sinnap Stream (Kuveik drainage-Kilis).

of 2012 and June of 2013 somewhat differs from the material described by Heckel (1843:1076). According to our data, it has 53-66 lateral line scales, 15-16 (17) branched anal-fin rays and 13-15 branched pectoral-fin rays, while in Heckel (1843), it has 65-70 lateral line scales, 17 branched anal-fin rays and 17 branched pectoral-fin rays. However our material from Sinnap Stream within Kuveik drainage share the same diagnostic characters of *Acanthobrama marmid* such as pectoral, pelvic and anal fins with orange pigments and the last unbranched dorsal-fin ray strongly thickened.

The morphological features are given below are based on the Sinnap Stream specimens: Body laterally highly compressed, head small, eyes large. Predorsal region hump forming (Fig. 6). Lateral line complete with 53 (1), 55 (1), 59 (3), 61 (2), 63 (1), 66 (2) + 2-3 perforated scales and 57 (1), 59 (2), 61 (2), 62 (2), 63 (3)+2-3 scales in lateral series, (12)13-14

scale rows between lateral line and dorsal fin origin; 6-7 scale rows between lateral line and the pelvic-fin origin; dorsal-fin with 8½ branched rays, anal-fin with 15 (1), 16 (8), 17 (1) ½ branched rays, pectoral-fin with 13-14, pelvic-fin 8-9 branched rays. Pharyngeal teeth in a single row, 5-5, 14-15 gill rakers on the first branchial arch, a well-developed and scaleless keel is present between anus and pelvic fin. Scales large and oval, transparent, circuli smooth, focus near anterior region and 5-7 radii only in the posterior field. Dorsal fin outer margin of partly concave, its last simple ray fairly thickened and strong, not notched and longer than other rays. Anal fin relatively long, outer margin of partly concave, pelvic axillary present, peritoneum dark smoky coloured and spotted.

**Colouration:** Formalin preserved specimens dorsally grey, ventrally bright silvery coloured, with a 2-3 scale rows wide dark band extending from the



**Fig.7.** *Acanthobrama* cf. *marmid* IFC-ESUF 03.0151, 175.9 mm SL, Sir Dam Lake (Ceyhan River drainage-Kahramanmaraş).



**Fig. 8.** *Acanthobrama orontis* IFC-ESUF 03.0154, 149.8 mm SL, (Seyhan Dam Lake)

posterior of operculum to the caudal fin base; all fins transparent, dorsal and caudal fin outer margins light black banded, some parts of pectoral, pelvic, anal and caudal fins orange coloured.

#### ***Acanthobrama* cf. *marmid* (Ceyhan River)**

*Acanthobrama* cf. *marmid* differs from *A. marmid* by having more complete lateral line scales (69-74+2-3, vs. 53-66+2-3), more scale rows between lateral line and dorsal fin origin (14-15, vs. 12-14), less branched anal-fin rays (13-15, vs. 15-17) and more gill rakers on the first branchial arch (23-24, vs. 14-15) (Fig. 7).

#### ***Acanthobrama orontis* Berg, 1948**

Body laterally compressed and high, predorsal region without hump. Mouth subterminal, lips thin. Head broad, snout slightly pointed. Scales fairly large, transparent and irregular. Ventral fin starts from slightly ahead of dorsal, outer margin of which is smooth, last simple ray thickened, except for the 22% elastic distal part. Outer margins of dorsal and anal fins slightly concave and smooth. Anal scaly. A weak

keel between ventral and anal. Pectoral fins short, not reaching ventral fins, and with pointed tips. Ventral fins pointed, but not reaching to the vent. Pelvic axillary present (Figs. 8-9), lateral line complete 47-59+1-2, lateral series has 49-58+1-2 scales. Between lateral line and dorsal fin 10-11, between the lateral line and ventral fin 5 transverse scale rows. D III 8, A 14-16, P 13-15, V 8. Pharyngeal teeth in a single row, 5-4 or 5-5. Gill rakers 19-21, thick and pointed. Scales oval-shaped, focus near anterior field, 5-7 radii only in the posterior field. Vertebral formulae 41: 21-22+19-20. Relative ratio of abdominal vertebrae 51-53%, predorsal vertebrae ratio 29-31%. **Colouration:** Dorsally grey or light brown, ventrally cream coloured, an indistinct band present between operculum and caudal peduncle. Dorsal and caudal fins colourless. Anal black band on each outer caudal and pectoral fin, anterior dorsal and anal fins; also 3 scales with a broad black band between operculum and caudal fin base.

**Remarks:** *Acanthobrama orontis* differs from *A. centisquama* (according to description of Heckel



**Fig. 9.** *Acanthobrama orontis* IFC-ESUF 03.0156, 139.9 mm SL, (Berdan Stream, Tarsus).

**Table 1.** Some morphological features of *Acanthobrama* species distributed in Turkey

Locality	L.L.	Sq	L.T.	D	A	Gill rakers	Pharyngeal teeth	Vertebrae
<i>A. marmid</i> Dicle River	61-77		12-14/6-8	8-9	15-18	15-17	5-5	41-42:20-22+20-21
<i>A. marmid</i> Firat River	61-67	58-65	12-14/6-7	8	16-18	14-15	5-5, 1.5-5	42-44:21-22+21-22
<i>A. marmid</i> Sinnap Stream	53-62	59-63	13-14/6-7	8	15-17	14-15	5-5	43:21-23+20-22
<i>A. orontis</i> Seyhan River	47-59	49-58	10-11/5	8	14-16	19-21	5-5, 5-4	41:21-22+19-20
<i>A. orontis</i> Berdan Stream	48-61	49-59	10-12/5-6	8	14-15	17-19	5-5	41-42:21+20-21
<i>Acanthobrama</i> cf. <i>marmid</i> Ceyhan River	69-74	73-80	14-15/7	8	15	23-24	5-5, 4-5, 5-6	42:22+20
<i>A. microlepis</i> Aras River	70-83	70-83	12-14/6-7	8	14-16	10-11	2.5-5.2, 1.5-5.2	44-45:22-23+22

1843) by having less lateral line scales (47-61, vs. 100) and less scales between origin of dorsal-fin base and lateral line (10-12, vs. 20), less scales between origin of anal-fin base and lateral line (5-6, vs. 10) and less branched anal-fin rays (14-16, vs. 20).

### Discussion and Conclusions

Most distinctive features of the genus *Acanthalburnus* Berg, 1916 are all shared with *Acanthobrama*: fusiform and laterally highly compressed body, thickened last simple ray of dorsal fin, a deep keel between anal and pelvic fins, short and thick gill rakers. The number of vertebrae, vertebral formulae, maxilla, ceratobranchial,

supraethmoid, and hyomandibular bones are also similar. Beside the above affinities, there are some differences between both genera; pharyngeal teeth two rows (2.5-5.2 or 1.5-5.2) in *Acanthalburnus*, while generally one row (5-5, rarely 1.5-5) in genus *Acanthobrama*. Also genera *Acanthalburnus* have more vertebrae than *Acanthobrama* (44-45:22-23+22, vs. 41-44:20-23+19-22). These differentiations can be considered a peculiar variation. Accordingly, as proposed by Perea et al. (2010) and Eschmeyer (2014), transfer of *Acanthalburnus microlepis* Berg, 1916 into the genus *Acanthobrama* (De Filippi 1863) and synonymization of *Acanthalburnus* with



*Acanthobrama* are also supported by morphological characters. Some morphological features of *Acanthobrama* taxa investigated in this study are given in Table 1.

In our study, the most important morphological differences among the species studied were the scale numbers of the lateral line, scale rows between lateral line and dorsal fin origin and scale rows between lateral line and the pelvic fin origin, gill rakers on the first branchial arch and gill raker numbers. The original description of *A. marmid* from Kuveik Heckel (1843) is apparently congruent with that of Dicle River population (Table 1): 65-70 scales in lateral line, 9 scale rows between lateral line and dorsal fin origin, 8-9 scale rows between lateral line and pelvic fin origin. Especially, Ceyhan River population might prove to be a new *Acanthobrama* species considering its body shape, higher number of lateral line scales (69-74), deep serration in posterior field of the scales and higher number of gill rakers (23-24). The same issue was also argued by Kara et al. (2010). Bogutskaya (1997) reported that only *A. marmid* is distributed in Dicle, Fırat, Kuveik, Asi Rivers and Amik Lake, but *A. orontis* was reported by Berg (1949) from Amik Lake, significantly differs from *A. marmid* on the taxonomical grounds and indeed the Seyhan River population is morphologically very close to this species. We checked most of the Asi River drainage in Turkey, although we have not found any specimens. *Acanthobrama orontis* is distinguished from *A. marmid* by having less scale rows between dorsal-fin origin and ligne lateral (10-12, vs. 12-14), less scale rows between ligne lateral and ventral-fin origin (5-6, vs. 6-8) and more gill rakers on the first branchial arch (17-21, vs. 14-17). *Acanthobrama orontis* is distinguished from *Acanthobrama* cf. *marmid* by having less scale rows between dorsal-fin origin and the lateral line (10-12, vs. 12-15), less scale rows between lateral line and ventral-fin origin (5-6, vs. 7) and more gill rakers on the first branchial arch (23-24, vs. 17-21). Thus *A. orontis* of Berg (1949) should be considered valid.

In conclusion, it is understood that the genus *Acanthobrama* is represented by 4 taxonomically distinct species in Turkey: *A. marmid* (Dicle and Fırat rivers), *A. microlepis* (Kura and Aras rivers), *Acanthobrama* cf. *marmid* (Ceyhan River) and *A. orontis* (Asi and Seyhan rivers, and Berdan Stream).

## References

- Berg, L.S. 1949. *Freshwater fishes of the U.S.S.R. and adjacent countries*. Volume: 1-2-3. Izdatelstvo Akademii Nauk SSSR, Moskova & Leningrad.
- Bogutskaya, N.G. 1996. Contribution to the knowledge of leuciscine fishes of Asia Minor. Part 1. Morphology and taxonomic relationships of *Leuciscus borysthenicus* (Kessler), *Leuciscus smyrnaeus* Boulenger and *Ladigoesocypris ghigii* (Gianferrari) (Cyprinidae, Pisces). *Publicaciones Especiales Instituto Espanol de Oceanografia* 21: 25-44.
- Bogutskaya, N.G. 1997. Contribution to the knowledge of leuciscine fishes of Asia Minor Part 2. An annotated checklist of leuciscine fishes (Leuciscinae, Cyprinidae) of Turkey with descriptions of a new species and two new subspecies. *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut* 94: 161-186.
- Chen, X.L.; Yue, P.Q. & Lin, R.D. 1984. Major groups within the family Cyprinidae and their phylogenetic relationship. *Acta Zoologica Sinica* 9: 424-440.
- Coad, B.W. 1984. *Acanthobrama centisquama* Heckel and validity of the genus *Mirogrex* Goren, Fishelson and Trewavas (Osteichthyes: Cyprinidae). *Hydrobiologia* 109: 275-278.
- Coad, B. 2014. <http://www.briancoad.com/main.asp>.
- Durand, J.D.; Tsigenopoulos, C.S.; Ünlü, E. & Berrebi, P. 2002. Phylogeny and Biogeography of the family Cyprinidae in the Middle East inferred from cytochrome b DNA-Evolutionary significance of this region. *Molecular Phylogenetics & Evolution* 22 (1): 91-100.
- Eschmeyer, 2014. California Academy of Sciences, <http://research.calacademy.org/redirect?url=http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp>.
- Esmaili, H.R.; Coad, B.W.; Gholamifard, A.; Nazari, N. & Teimory, A. 2010. Annotated checklist of the

- freshwater fishes of Iran. *Zoosystematica Rossica* 19: 361–386.
- Freyhof, J. & Özüluğ, M. 2009. *Pseudophoxinus evliya*, a new species of spring minnow from Western Anatolia with remarks on the distribution of *P. ninae* and the systematic position of *P. fahirae* (Teleostei: Cyprinidae). *Ichthyological Exploration of Freshwaters* 20: 309–318.
- Heckel, J.J. 1843. *Ichthyologie*. In: Russeger, J. (ed.). *Reisen in Europa, Asien und Afrika mit besonderer Rücksicht auf die naturwissenschaftlichen Verhältnisse der betreffenden Länder, unternommen in den Jahren 1835 bis 1841*. Erster Band. Reise in Griechenland, Unteregypten, im nördlichen Syrien und südöstlichen Kleinasien. Teil 2. Schweizerbart, Stuttgart, 991–1099.
- Kara, C.; Alp, A. & Şimşekli, M. 2010. Distribution of Fish Fauna on the Upper and Middle Basin of Ceylan River, Turkey. *Turkish Journal of Fisheries and Aquatics Sciences* 10:111–122.
- Karaman, M.S. 1972. Süßwasserfische der Türkei. 9 Teil. Revision einiger kleinwüchsiger *Cyprinidengattungen Phoxinellus, Leucaspius, Acanthobrama* usw. aus Südeuropa, Kleinasien, Vorder-Asien und Nord Africa. *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut* 69: 115–155.
- Kosswig, C. 1955. Zoogeography of the Near East. *Systematic Biology* 4: 49–73.
- Kottelat, M. & Freyhof, J. 2007. *Handbook of European freshwater fishes*. Kottelat, Cornol and Freyhof, Berlin, Germany. 646 p.
- Ladiges, W. 1960. Süßwasserfische der Türkei, I. Teil.: Cyprinidae. *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut* 58: 105–150.
- Mayden, R.L. & Chen, W.J. 2010. The world's smallest vertebrae species of the genus *Paedocypris*: A new family of freshwater fishes and the sister group of the world's most diverse clade of freshwater fishes (Teleostei: Cypriniformes). *Molecular Phylogenetics and Evolution* 57 (1): 152–175.
- Naseka, A. M. 1996. Comparative study on vertebral column in the Gobioninae (Cyprinidae, Pisces) with special reference to its systematics. *Publicaciones Especiales Instituto Espanol de Oceanografia* 21: 149–167.
- Perea, S.; Böhme, M.; Zupančič, P.; Freyhof, J.; Šanda, R.; Özüluğ, M.; Abdoli, A. & Doadrio, I. 2010. Phylogenetic relationships and biogeographical patterns in Circum-Mediterranean subfamily Leuciscinae (Teleostei, Cyprinidae) inferred from both mitochondrial and nuclear data. *BMC Evolutionary Biology* 10: 265.